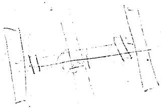
Notebook, N-89-10-29

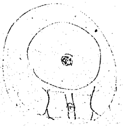
This notebook covers the period October 1889-January 1890. It was used by William Burlingham and another unidentified experimenter for notes, drawings, and calculations regarding an electric railway system. Related material can be found in Arthur E. Kennelly Notebook #2. The front cover is labeled "#573 Oct 29-Jan." The spine is labeled "99." The pages are unnumbered except for pages 44-53. Approximately 110 pages have been used.

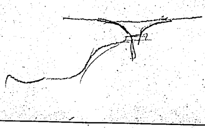
NE-172 N-89-10-29

#573

W Burlingham
Oct 29. 89





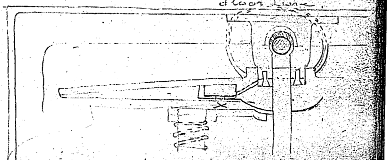


Street Car System

Sketches

3600

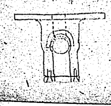
8 miles
Motor 1400.
Floor Line

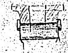


Would advise making tension of spring adjustable by a nut &c.

Better to have roller or ball bearings Or at least instead of a ball bearing to make this part cylindrical and let it be merely a guide.

Sketch of Tops bearing





Worm

Oct 29
89

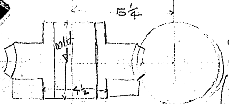
3/4" Pitch - 4.187 diamet, Pitch

4.187) 27.00000 (6.44
25134
18660
16756
19040
16756

Dia. 6.44

6.44
3.22
1.5
4.72

Worm and wheel designed by J. G. New York Office



dia of Gear at middle 6.95
(7-1)
Cutter

Worm wheel 6½" diameter 2" deep. 27 teeth 3/4 Pitch Machined on Bores & sides

Worm 4 threads 3" Pitch
4" Pitch diameter. (Quadruple thread)
Outside diameter 4.45 about 4½
Worm 4" over end
Bore 2"
Gear bored to car axle

4
3.22
2
6.22
.3 p
.3
.75
.3
.225
.225
1/4"
4½ 4.45
24
46
6.5
6.75
6.24
4) 1400
350

Motor 1400. 4000 ft per minute
Car wheels are 30" dia.
9 miles per hour. 5280 × 9 = 47520 ft
~~30~~
2.5 ft dia
circ = 7.854

7.854) 47520.0000 (6050.4
47124
39600
39270
33000

60) 6050 per hour
101 turns.

100 turns per minute.
100 turns of gear,
Worm & gear are 1:7.
∴ 700 turns of worm and
∴ 7 friction plate.

8" Cone friction 24" 3. 3) 2400 / 700
4.
12" dia 4) 9 / 2.25

Sent a letter to [illegible] Chem. Co. asking time required and price for the [illegible] — Oct. 28

Efficiency of worm gear

$$\xi = \frac{\cot\theta}{\cot(\theta-\phi)} = \frac{1-\mu\frac{p}{2\pi r}}{1+\mu\frac{2\pi r}{p}}$$

θ = angle of worm thread
μ = coefficient of friction
r = radius of the worm
ϕ = angle of repose between metal & metal
ξ = efficiency of the pair

$\frac{34000}{10}$

x 1°

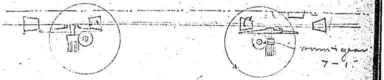
20 - 15

12 - 16

15

6

Methods of speed regulation.

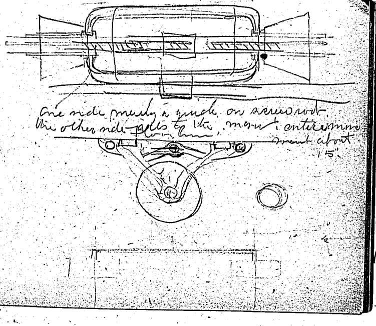


Car wheel 100 Rev.
Worm 700 " "
Armature 1400 " "
} per m.

Peripheral speed 4000 ft.

Remarks

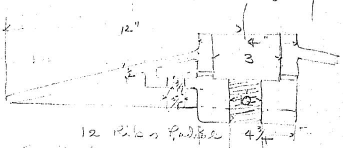
Screw shaft in [illegible] of motor [illegible].



One side purely a guide on screw rod.
The other side acts to the [illegible], mount entire armature about 15".

Discussion with Pattern Maker

Oct 29


12"
4"
3
½
1¾
⅜
4¾

12 Ribs Paddle

No oil holes.

do away with ball bearings,

[illegible] to be secured

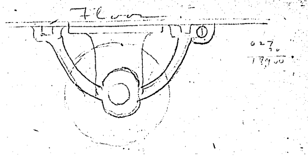
by [illegible] with pin.

Have been Pattern makers table bearing

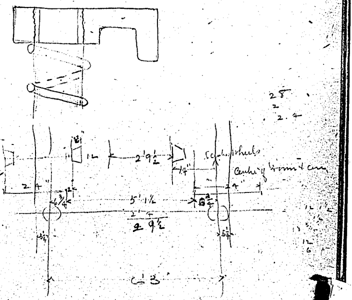
for [illegible].

Centre of wheel to rail = 15"

Rail to trolley beam 2 3½
2
2 5½
1 4
10½



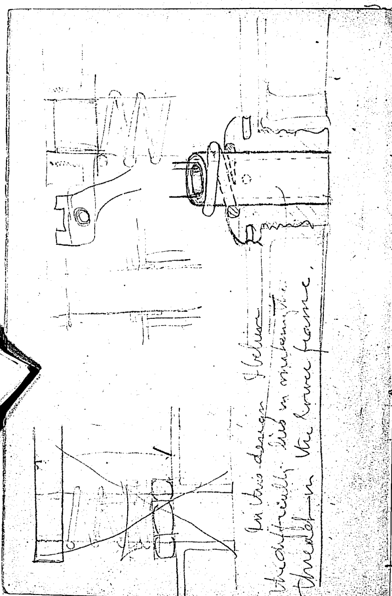
027
7700


2'9½
14"
Center of wheels
Center of [illegible]
2 4"
2 4"
6¾
5'1½
8¾
2' 4
2 9½
5¼
5¼
6'3

28
2
2.4

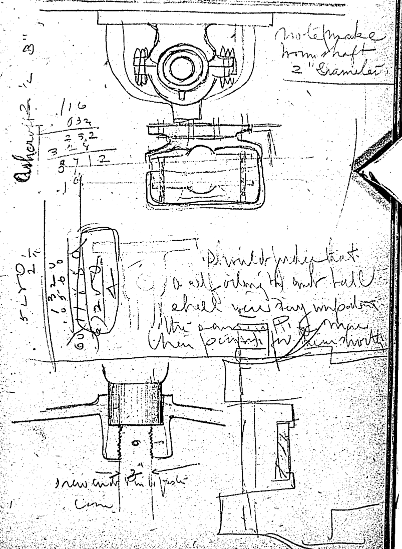
12 1½

12
6



In this design I believe the difficulty lies in making the thread in the lower frame.

7 lam line



Not to make worm shaft 2" diameter

Ashcroft 2 1/2 3"

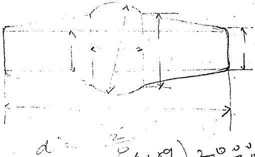
.116
.032
2.52
3.24
3.7 | 2
.64
5LYO
2 1/2
1.320
.0560
60

I would prefer that a self oiling thrust ball shell were very important the same P¹ ... more their pressure for the main shaft

screw cut 3/4" Pin lift

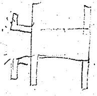
line

240
40



d" = 2/D

4.189) 2.0000 (.477
1 6756
32440
29323
31170



.477

1) 1.57
.39
X

2/X

.125
.5
1.03
.53

3/4" cir P = 4.189 Diametral Pitch

$t = \frac{1.57}{4.189}$ = middle of tooth on P. circle .374

D" = $\frac{2}{4.189}$

working depth .477
.0374
.514

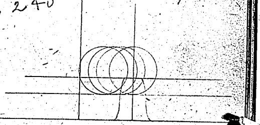
$f = \frac{t}{10}$ = $\frac{.374}{10}$ = .0374

.477
.037
.514
.374

4.189) 1.570000 (.374
1 2567
31330
29323
20070
16756
33240

10) .374
.0374

4.189) 2.000000 (.477
1 6756
32440
29323
31170



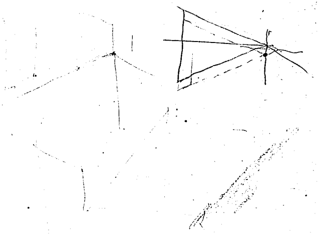
D = $\frac{27+2}{4.189}$

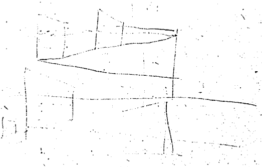
4.189) 29.00000 (6.92 Whole
25134
38660
37701
9590

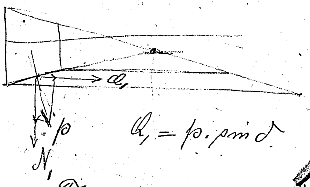
6.44
.48
.24

D' = 4.189) 27.00000 (6.44
25134
18660
16756
19040
16756

.48
.24







$Q_1 = p . \sin \delta$

$p = \frac{T}{\mu}$

$T = \frac{550 \, HP}{v \text{ feet/sec}} = \frac{550 \times 8}{22.7}$

smallest $v =$ [24" dia]

$\frac{1300 \times}{6} =$

$v = 6.28 \times \frac{217}{60} = 22.7$ feet/sec

$T = 190$ lbs

$p_{.02} = \frac{T}{\mu} = \frac{190}{.2} = \underline{\underline{950}}$ lbs

$Q_1 = p . \sin\delta$; $1{:}6 = \frac{4}{6}$ 50 each

$tg\,\delta = \frac{4}{36} = .166$

$\delta = 9^\circ 28'$

$Q_1 = 950 \times .164 = \underline{\underline{156}}$ lbs

Crank 12" $\overset{}{8} = 15$ -- 3 times round ~~to~~ 40 make whole travel $3.8 \times 3 = 11.4''$

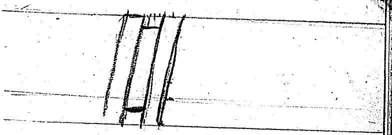
$114 : 8 = 14$ | $156 : 14 = 11$ lbs pressure

$T = t.\beta$; $t = 60$ lbs pr inch of face

$\beta = \frac{T}{t} = \frac{190}{60} \doteq 3\frac{1}{2}''$

11 lbs pressure on handle

$\frac{1}{4}$

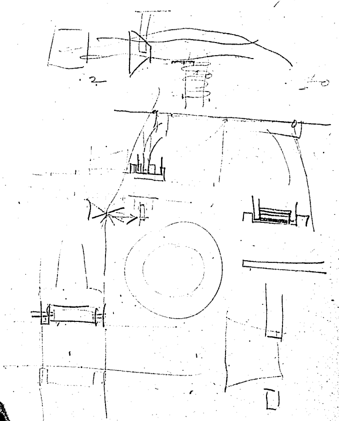


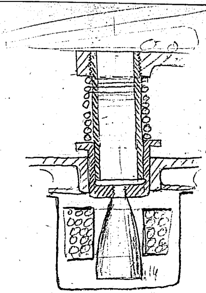
Screw 8" travel $\frac{1}{4}$" pitch

32 turns, 8" movement

(2" x 10") 2 gears.

3 turns for reversing.

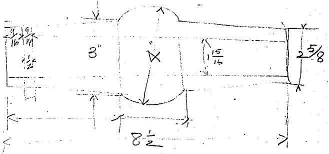




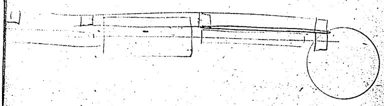
Oct 31. 89.

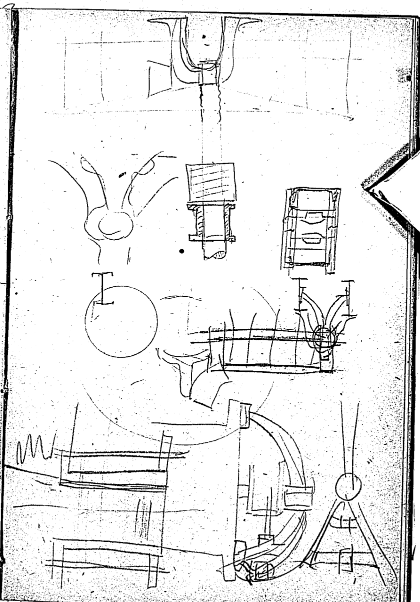
K

#6


9/16
9/16
1 1/2"
3"
4"
1 15/16
2 5/8
8 1/2

Use a regular Drop Hanger with a box designed to be selfoiling.





5280 × 7

37960

Calculating of Spring

D. Mic = .25

r = 2.75

G = 11000000

f = 15000

W = 300 lbs

δ = 1½

δ

n = number of coils 10 coils

2½ 2¾

$.275^3$

20.796875

20.7

$\delta = \frac{300 \cdot 64 \cdot 10 \cdot 20.8}{11000000}$ .0039

6400
20.8
5120
1280
133120
300
39936000

11
39
39
429000000
42900

42900)39936000(9

1) $\frac{1\frac{3}{4}}{\frac{7}{4}}$

$W_1 = \frac{.196 f D^3}{2}$

$1\frac{3}{4}$

$3\frac{3}{4}$ 4. 12

12

$\frac{1}{3}$ $\frac{1}{4}$

$\frac{10}{4}$ 2½

.25

15000
.615
75000
15000
225000
.196
1350
2025
225
44100

.015625
.25
78125
31250
.00390625

.0039

∂

$$1.25 = \frac{\overset{8}{\cancel{300}} \cdot \overset{64}{\cancel{10}} \cdot r^3}{1100000 \cdot \cancel{.375}}$$
.125

$$1.25 = \frac{r^3}{.125 \times 11000}$$

125
1375,000

$r^3 = 718.75$

$$1.25 = \frac{r^3}{1375}$$

$r = 9''$

1375
1.25
6875
2750
375
718.75

$64 r^3 = \frac{718}{64}$ 1

3/8 3/8 3/8 3 3/..
2 1/2
5 1/2

$$\delta = W\frac{64\, n\ r^3}{G\, d^2}$$

$$\cancel{1.25} = \frac{\cancel{300}\ \overset{32}{\cancel{64}} \cdot \cancel{10} \cdot r^3}{\cancel{1100000} \cdot \cancel{.375}}$$

5500
1100

.125

$.125 = \frac{32\, r^3}{1100}$

4400. 1.25) .375 (3

1100
.125
1375.00
125
7
6875
2750
375
3.7,3 7.5

1.25) 30

$$\cancel{1.25} = \frac{\cancel{300}.64.10.r^3}{1100000.\cancel{.375}}$$

$$r = \frac{64\, r^3}{1100}$$

$$1 = \left(\frac{64}{1100}\right)\left(r^3\right)$$

$$r^3 = \frac{1100}{64}$$

$r^3 = 17$

17

64) 1100 (17
64
460
448
120
6

: ~~8~~ 16 1,25

~~2,5~~

$$1{,}25 = \frac{3\cancel{00} \cdot 64 \cdot \cancel{10} \cdot 7^3}{\cancel{1100000} \cdot \cancel{25}\ 1{,}3}$$

4400

$$1 = \frac{192 \cdot 7^3}{\cancel{4}400}$$

2,5) 11000 (4400

100

1000

100

$$7^3 = \frac{4400}{192}$$

192) 4400 (

10 8

$$1{,}25 = \frac{\cancel{300} \cdot 64 \cdot \cancel{12} \cdot 7^3}{\cancel{1100000}\ \cancel{,375}}$$

2750 ~~13~~

192) 2750 (14

192

830

768

14,

---

5 3 32 8

$$\cancel{1{,}25} = \frac{3\cancel{00} \cdot \cancel{64} \cdot \cancel{12} \cdot 7^3}{\cancel{1100000}\ \cancel{,25}}$$

~~220000~~

~~5500~~

2750

96

3

288

$$7^3 = \frac{2750}{288}$$

288) 2750,000 (9,7

2592

1580

8

~~10~~

~~32~~ ~~57~~

$$\cancel{1{,}25} = \frac{3\cancel{00} \cdot 64 \cdot \cancel{14} \cdot 7^3}{\cancel{1100000}\ \cancel{,25}\ \cancel{8}}$$

~~22000~~

~~11000~~

~~5500~~

~~2750~~

1375

24

7

168

$7^3 = 8$

8 7 = 2

$7^3 = 168$

1375

1344

$$W_1 = \frac{0.196\, f\, d^3}{7}$$

.25

$$W_1 = \frac{196 \cdot \overset{10000}{\cancel{20000}} \cdot .015\cancel{625}}{\cancel{2}}$$

196
150
9800
196
29400

.150000

5
4
25

$$W_1 = \frac{196 \cdot \overset{4000}{\cancel{2000}} \cdot .0125}{\cancel{425}}$$

980
392
196
.024500
4000
4980000

~~1.5~~
.3

4000

3)980(327
9
08
6
20

$$\frac{12{,}566\, n\, f\, r^2}{60}$$

1.5
1.5
1.75
1.5
2.25

.45

$$\frac{12{,}566 \cdot \overset{20}{\cancel{10}} \cdot \cancel{20000} \cdot \cancel{2.25}}{\cancel{110000} \cdot \cancel{5}}$$

~~55~~

$\frac{1}{2}$

3 11 12,566
.45
62830
50264
565470

11)5,654
5

$$\frac{12{,}566\; \overset{7}{\cancel{14}} \cdot \cancel{20000}}{\cancel{110000}} \;\; \cancel{5}$$

~~550~~
275

~~4.5~~
~~2.25~~
45

13)2.25(45
20
.2

4.5
1.5
2.25

12,566
.45
62830
50264
565470

11)56.5470
5

7
1.3755

3
4

2)3.55(1.
2 7 5
12 0 00

15
1.5
75
15
2.25

$$\frac{12.566 \cdot n \cdot f \cdot r^2}{11000000 \cdot 5}$$

.9
~~4.5~~

$$\frac{12.566 \cdot \cancel{1.5} \cdot \cancel{20000} \cdot \cancel{2.25}}{\cancel{11000000} \cdot \cancel{.5}}$$

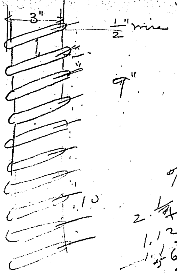
~~55~~
11

12,566
.9

11.3094

11) 11.30
1.13

1.03 Greatest extension of Compression

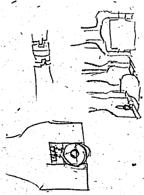


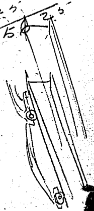
9/2

2 . ~~1/4~~

1.125
1.125
5625
2250
1125
1125
1.2656
25

1.20





R

1.350) 33000

Nov. 1st 89

$$T = \frac{550\,HP}{V\ \text{feet/sec}}$$ = Tangential force, see Nov 7th

---

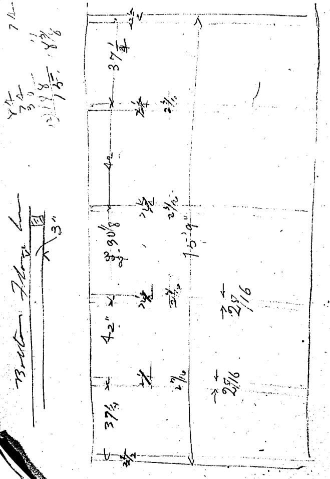
$$v = 1.57 \times \frac{1300}{60} = 34\ \text{feet/sec}$$

$$T = \frac{550 \times 8}{34} = \underline{130}\ \text{lbs}$$

$$P = \frac{T}{\mu} = \frac{130}{.2} = \underline{650}\ \text{lbs}$$

$$Q_1 = P \sin \delta = \underline{650 \times .139} = \underline{90}\ \text{lbs}$$

$$Q_2 = P \cos \delta \doteq \underline{650}\ \text{lbs}$$


Bolt Flange
3"
37 1/4
42
42"
37 1/4
3 9/16
15'-9"
2 5/16
2 5/16
7 1/4
8 3/16

Spring ~~[illegible]~~ 1.
alternates

Y

609 lbs - 6 1/4
900 lbs - 8 3/8
2 1/4 dia   9 5/8
3/8 min   200 lb = 1 1/4"
8 1/4
15 coils

196 . ~~20000~~ 800 . ~~05~~

~~1125~~
196   .9

136,800

(.9) 136.800 (175 greatest load

$D = \frac{12566 \, n f r^2}{Q D_3}$

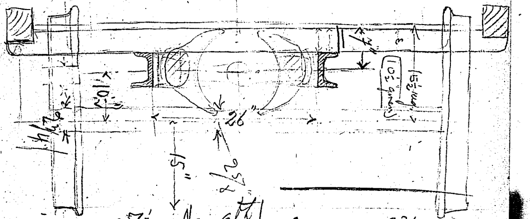
$\frac{12566 \quad \cancel{15}\,3 \quad \cancel{20000} \,.\, \cancel{126}\,42}{\cancel{1100000}\,110 \,.\, \cancel{375}\,.125}$

(12566)(42)(.3) 15.83

13.73

(.125)(110) = 13.75

1.2"


15½ req.
10½ given
7"
26"
25⅞"
15"
10½"
2¾"

Nov. 6th

7
10½
17½
10½

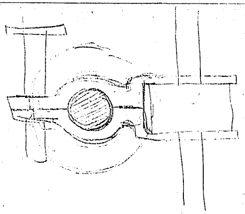
7" Car to be raised!

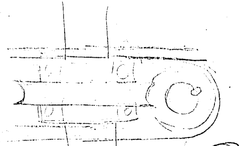
6½
10½
17
10½
6½" Car to be raised 6½"

23½
2
25½
15
10½

15
8¼
6½
9¾
6½

car to ~~be raised~~

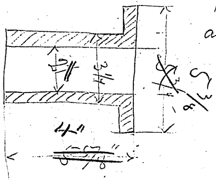




~~Oct~~ Nov 2 89

[illegible] Kennelly

34 X 22 X 13.

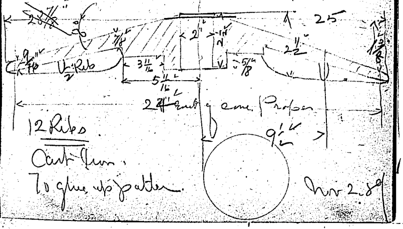

2 1/4"
3 1/4"
4"
~~6 7/8"~~

Finished all over

Changed Nov 6th

Bronze shell for paper arm on Street Car Motor

Nov 2nd 1889. K

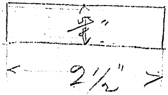

~~23 7/16"~~
7/8"
9/16"
1/2" Rib
3 11/16"
5 11/16"
2"
1/16"
5/8"
2 1/2"
25
1 3/8
24" end of arm. Proper
9 1/2"

12 Ribs

Cast Iron.

To glue up pattern.

Nov 2.89

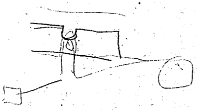


60 of these

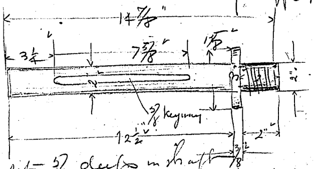
Steel rollers for S.C. Motor

D

5th Nov 89. K



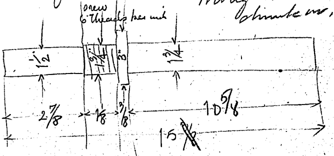
Nov 5, 89. WB.


14 7/8"
3 1/4"
7 5/8"
1 5/8"
2"
5/8 keyway
12 1/2"
2"
3/8

set 5/16 deep in shaft

Try this. Machine steel

Wrought iron collars shrunk on.


screw 6 threads per inch
1/2
1 3/4
3"
1 3/4
2 7/8
1/8
3/8
10 5/8
15 ~~1/8~~

Try this.

Machine steel. WB.

In the worm should be set the key and the keyway rounded off on edges.

$$\frac{12 \times 60}{720}$$

Pitch of screw: $1\frac{1}{4}$" dia square thread:

$$p = 0{\cdot}16d + 0{\cdot}08$$
$$= 0{\cdot}16 \times 1{\cdot}25 + 0{\cdot}08$$
$$= {\cdot}28''$$

Make 4 threads to the inch = ·25" pitch

Power motion of screw.

Nov 5th K.

Screw $1\frac{1}{2}$" dia
$\frac{1}{14}$" pitch }

3 Seconds to stop the car from $9\frac{1}{2}$ miles speed

6 seconds to reverse motion between highest speeds.

Trave of paper cone $17\frac{1}{2}$" ($16\frac{1}{2}$

Revol of screw $17\frac{1}{2} : \frac{1}{14}$ → $16\frac{1}{2}$ (Nov 13th 89) K

= 70 revol in 6 seconds
8 sec

Revol of motor in 6 seconds:

$$6 \times \frac{1350}{60} = 135$$

Therefore Gears. 135:70 = 2·57

~~Centre distance betw gears = 9"~~

~~$\frac{R}{r} = 2.57$~~

~~3.57~~

~~$9 : 3.57 = 2.5$~~

~~$R = 6\frac{1}{2}$~~

~~$r = 2\frac{1}{2}$~~

Centre distance betw. gears = 8½

$R = 5\frac{1}{2}''$

$r = 2\frac{3}{4}''$

Tangential force   Nov 7th

$$T = \frac{550 \times HP}{V \frac{feet}{sec}} = \frac{550 \times 9}{38.5} =$$

$$v = 1.57 \times \frac{1350}{60} = 38.5 \text{ feet/sec}$$

$$T = \underline{130 \text{ lbs}}$$

P.D of cone $5\frac{1}{8}''$

$$P = \frac{T}{2} = \frac{130}{2} = 65.0 \text{ lbs}$$

$$R_2 = P \sin \delta = \frac{650 \times .139}{90 \text{ lbs}} \text{ on screw}$$

P dia of screw $1\frac{1}{4}''$

P dia of gear 9"

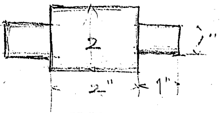
~~smaller~~ $9'' \times x^{lbs} = 1\frac{1}{4}'' \times 100^{lbs}$

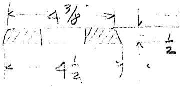
$x = 13^{lbs}$ 6 Pitch

Continued page 52

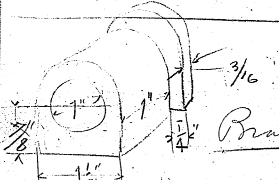
46

John Prange. Nov. 6 89



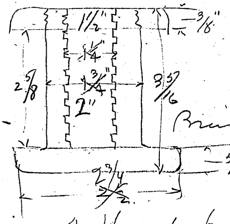


Wrought Iron.


3/16
1"
1"
7/8"
1/4"
1 1/2"

Brass.

47

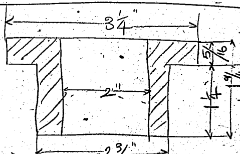

1 1/2"
3/8"
1 1/4"
1 3/4"
2"
2 5/8
3 5/16
5/16
2 3/4
~~2 1/2~~

Brass.

Altered Nov. 7th K.

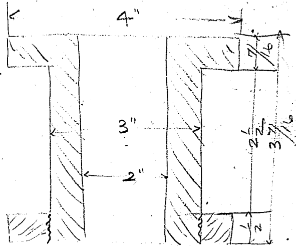
4 threads per inch

2 of these with thread 2 groove
2 of ~~without~~ thread


3 1/4"
5/16
9/16
1 1/4
2"
2 3/4"

Brass. 2 of this

WB. Nov 6 89.


4"
7/16
3"
2 1/2
3 7/16
2"
1
2

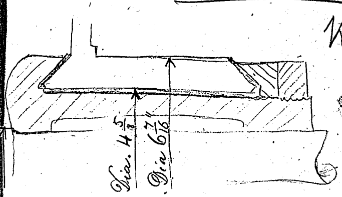
2 of Phos. Bronze.
Finish all over.

WB. Nov 6 89

Commutator 60 divisions

Nov 7th 89

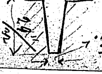
K.


Dia. 4 5/8
Dia 6 7/16

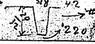
Inside dia. ~~4~~ 4 5/8

Circumf = 14·53 : 60 = ·242
Mica ·024
Bar on ~~top~~ bottom ·218

Outside dia. 6 7/16", depth of bar 29/32".

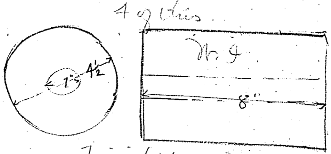


6 7/16 — — 20·0277
+ ·1963
20·224 : 60 = ·337
·024
·313"

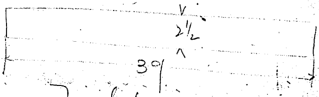

·318
22/42
·220
#1 Bar

Nov 7. 89.

4 of this.



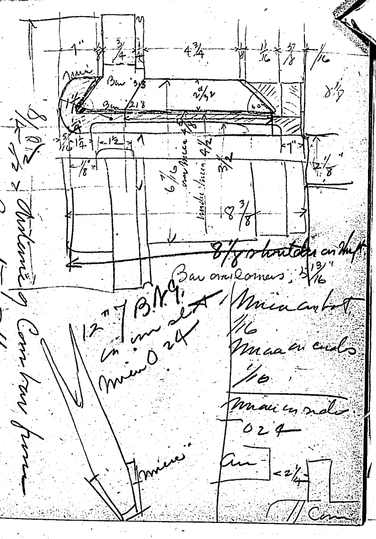
Finished sizes



Finished sizes
~~Hammered steel~~

Nov 7

Use 2 #12 Brushes and Brush holders.


1"
¾
¼
4¾
11/16
5/8
1/16
8⅛
Bar 3/8
2¾
Bar 218
60°
1¼
1½
1
1"
2⅛
1/8
6 7/16
4½
3½
8 3/8
mica
mica
Arm
<2¼
Com

8½ < Armature Core fibre
Armature 2¼

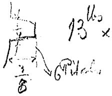
8⅞ solid steel on shaft

Bar on Commu. 5 13/16"

12" 7 B.W.G. in slot
in in slot
mica 0 24

Mica on top 1/16
Mica on ends 1/16
Mica in sides 024

Gears for screw movement



teeth at once

$$13^{lbs} \times .375 = \frac{2\times1}{6}\, 6 \cdot h^2 \times 200^{lbs}$$

for rawhide

$$13 \times {}^{3}/_{8} = \frac{1}{6} \times 6 \times \frac{1}{16} \times 200$$

$$b = \frac{13 \times 3 \times 6 \times 16}{8 \times \underset{100}{200} \times 2} = 1\tfrac{3}{8}''$$

13×3
39×6
234 : 100

made 1 3/4"

6 Pitch ; Gear p.dia: 5½ ×6 = 33 teeth
" p.dia: 11×6 = 66 "
" p.dia 4½×6 = 27 "
p.dia 9"×6 = 54 "

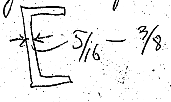
Order given Mr B for 2
1 1/16 Pillow Blocks.

When here have 1/8" taken off bottom making them
2 3/8 centre to foot of base

WB.

Order to Mr Thomas.
Nov 9th 89

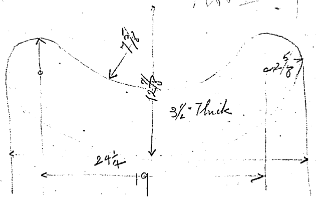
2 Channel irons each 16 feet long, 5" high



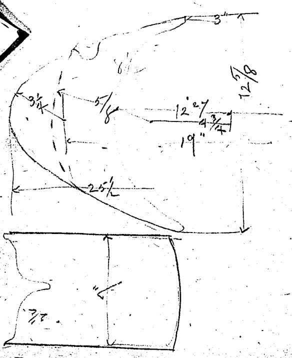
~~25 lbs per yard~~

27 lbs per yd

Nov 11 '89



7 7/8
12 7/8
2 5/8
3 1/2" Thick
24 1/4
19



3"
6 1/2
12 5/8
3 1/4
5/8
12 27
4 3/4
19"
25 1/2
4"
7/8

Nov. 11

To be made.

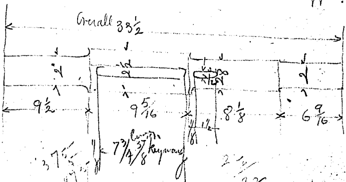
Guide bracket for screw box. behind Shaft.

Nov. 11. 89

Street-Car Motor Shaft.

Position and size of keyway will be given Later.

Hammered Steel. WB.


Overall 38½
2
2
2
9½
9 5/16
8 1/8
6 9/16
1½
7¾
3/8 Keyway
37
1.87
2 1/32
32

7¾

$\frac{32}{8} - 4\frac{1}{8}$

3 3/8

10) 3.62

.36

.35

8½ 3

11/2 .5½ 3.6 9.

Nov. 12. 89.

Number of coils. ——— 17

Diameter at ends. ——— 2

Diameter at middle. ——— 3 2. 3.

Length over all. ——— 7¾

Diameter of wire. ———

Constant f. ——— 20000.

Constant G. ——— 11000000.

If wire is square.

Width of Top wire 5/8 } ½" dia circle.

" side " wire ——— 3/8

W_1 - greatest safe steady load

$$W_1 = \frac{0.196 f \delta^3}{r}$$

$$\delta_1 = \frac{12566\, n f r^2}{G \delta}$$ Corresponding def or extension.

3/4" area

160
~~820~~
~~4000~~ 42
0'196 . ~~200000~~ . ~~42~~

~~1.25~~
~~.25~~
~~0.5~~

320
640
6920
.196
41420
62280.
6920
1356220 lbs ~~wgt~~

.75
.75
375
525
.5625
.75
28125
39375
.421875
.422

5/8" dia .625

16000.
0'196 . ~~20000~~ . ~~244~~

~~1.25~~

Area of 5/8 .306

3/4 x 1/2
3/8

5/8 x 1/2
5/16

750

244
16000.
1464
244
3904
.196
23424
35136
3904
765.184

0'196 . 20000 . (.5)^3 .125

1250

0'196 . ~~20000~~ 2010 . ~~.125~~

~~1.25~~

2,000
.196
12000
18000
2000
392,000

400 lbs per spring
8 springs
3200

1.25
1.25
625
250
125
1.5625

12566 . ~~11~~ . ~~20000~~ . ~~.156~~ .78

~~11007000~~ . 15
~~1007~~
~~50~~25

12566
.78
100528
87962
980148

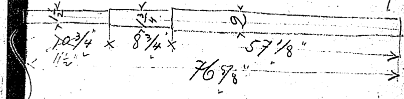
(12.5) 9.8014
8 3" inch
12 7

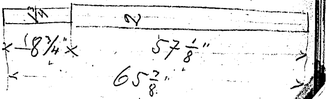
deflection about 3/4 inch
under load of 400 lbs

Make spring 5/8 x 1/2
11 coils.
Dia ends 2
middle 3
Length overall 8 1/2
coils space 3/10 inch

Car springs Nov 13
11 coils —
Dia at ends 2" outside
" " middle 3" outside
length overall 8½"
coils apart 3
Mesection 5/8 × 1/2"
8 of this
NB.

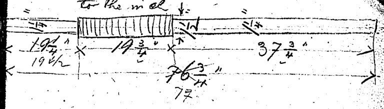
Main shafts Nov 13th 89

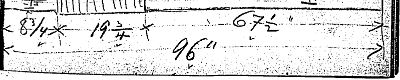

1½
1¾
2
~~10¾"~~
11½"
8¾
57⅛"
76⅝"


1¾
2
8¾"
57⅛"
65⅞"

Screw shafts

4 square threads to the inch


1¼
1½
1¼
~~19¼"~~
19½
19¾"
37¾"
~~76¾"~~
77


1½
1½
8¾
19¾
67½"
96"

Ordered Nov 13th

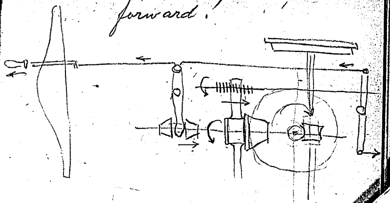
1 Wrought iron shaft 2" dia, 6 1/2 feet long
1 " " " 2" " 5 1/2 " "
1 " " " 1 1/2" " 6 1/2 " "
1 " " " 1 1/2 " 8 " "

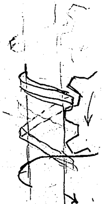
Ordered Nov 14 80

Recd from E M Wks, @ #12
Hammered Steel Shaft

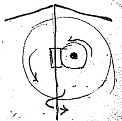
1/8.

forward!

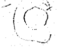


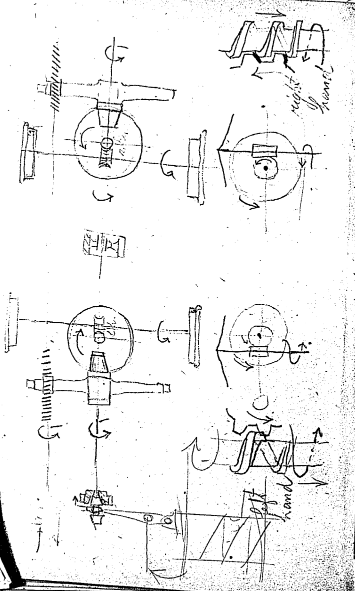


left hand



Armature shaft rotating in same direction as the hands of a watch in order to move car forward.





Nov. 18th 89

Approximate weight of parts:

Shaft	150 lbs
Screw	70 "
Channel irons	270 "
rods f. brackets	32 "
Cores f motor	135 "
Keepers	325 "
Pole pieces	190 "
Armature core	70 "
Commutator	50 "
Arm. wire	55 "
field "	100 "
fastening of arm.	30 "
2 pillow blocks	85 "
and bearings	60 "
4 screw bearings	60 "
" gears	60 "
Levers and links	50 "
Couplings	35 "
Worms and gears	75 "
2 Shafts f. conedises	27 "
4 " f. springs	30 "
	1960

	1960 lbs
2 main brackets	180
4 screw "	128
2 end "	60
Soundries	100
Total	2528
Discs	220
Bearings for them	100
Boxes for worms	35
	2883

Car springs

Car body 3000 lbs

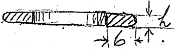
Motor 2400

$5400 \div 8 = 675$ lbs per spring

$$P = \frac{s}{3R} \frac{b^2h^2}{\sqrt{b^2+h^2}}$$

Take $R = 1\frac{1}{8}"$, mean dia $2\frac{1}{4}"$

make



Vose' Taper bar spring

$$\frac{b}{h} = \frac{2.5}{1};\ b = 2.5h$$

$$675 = \frac{14000}{3\times 1\frac{1}{8}} \frac{2.5^2h^2 \cdot h^2}{\sqrt{2.5^2h^2+h^2}}$$

$$= \frac{14000}{3.375} \frac{6.25h^4}{2.7h}$$

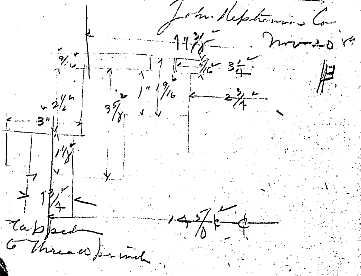
$$h = \sqrt[3]{\frac{675\times 3.375\times 2.7}{14000\times 6.25}} = .41"$$

$$\cong 3/8"$$

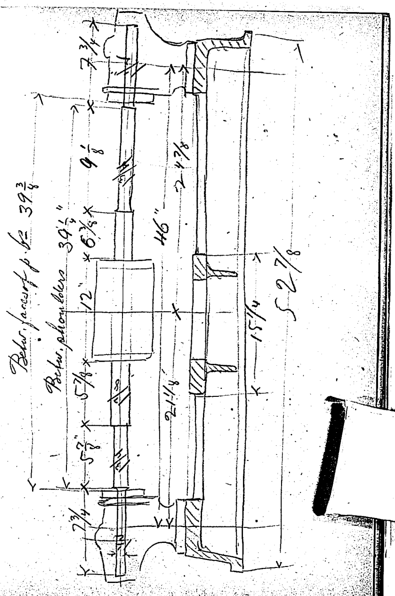
$h = \frac{3}{8}$; $6 = 2{\cdot}5 \times \frac{3}{8} = \underline{1''}$

40 ft radius Curves the wheel base can be opened to 7 ft. But with many curves about 27 ft radius the 6'3" base is quite enough.

John Stephenson Co.
Nov 20 '14


14 3/8"
9/16"
3/16"
3 1/4"
1"
1 9/16"
2 3/4"
2 1/2"
3 5/8"
3"
1 1/8"
1 3/4"
14 5/8"

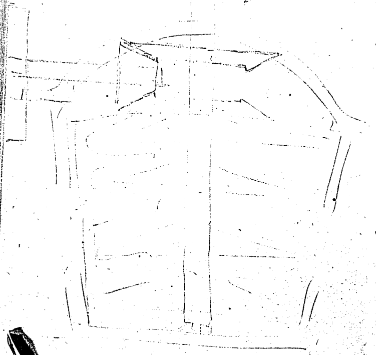
Tapped
6 threads per inch


Betw. faces of p. b = 39 3/4
Betw. shoulders 39 1/4"
7 3/4
9 1/8
6 3/8
12"
5 7/8
5 7/8
7 3/4
24 7/8
46"
21 1/8
15 1/4
52 7/8

Nov. 22. 1888.

Pinions for Mixer.

10" dia Plunger [illegible]



Bevel Gears. Nov 22 88

159 T. dia

~~Dia~~ 39 12.437 1 3/4 face Prd. Pitch

160 12 3.875 1 3/4 " 1 3.25 1"

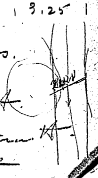
Progress Machine Works.

A + F Browns.

" 57 59 + 61 Lewis St.

60 62 64 66 Cannon St

New York



P = 63000

77) 252000 (

63000 . 8

22, 35

2695) 50410.0 (1800

2695

23450

21560

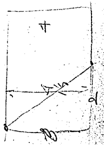
26

35

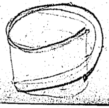
385

231

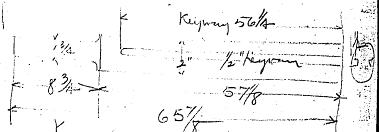
2695



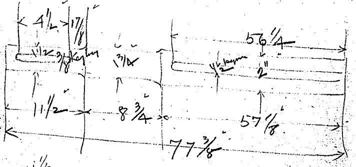
1900 lbs. circumferential force on the worm wheel at 77 Rev per m. and 8 HP.



Nov. 25. 1889


Keyway 56¼
1¾
2"
½" Keyway
8¾
57/8
65⅞

Keyway on one side 56¼ long,
" " other side 1½" long


4½
1⅞
1½
⅜ Keyway
1¾
56¼
½ keyway
2"
11½
8¾
57⅛
77⅜

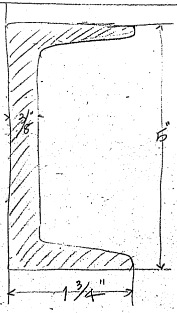
11½
8¾
57⅛
76
77⅜

1¾

one keyway 56¼ } long
opposite keyway 1½ }

Nov 25 1889

Centres of outside bearings. 12' 11¾"
Centres of Disc brackets. 7' 7½"
Centres of motor brackets 10¾ + 16½
Total length 15' 11." (Crossbeams 2½")
Distance between centres of beams.
37¼" – 42" – 30⅛ – 42" – 37¼
26" between the parallel channels. inside dimensions.



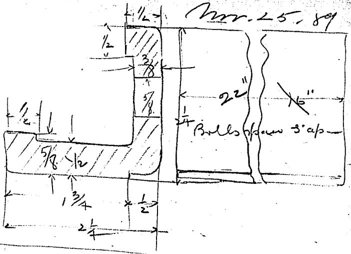
84

12
7
84
7½
91½

98

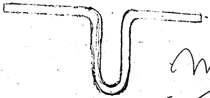
9½
10½
102

Nov. 25. 89


1/2
1/2
3/8
5/8
1/2
5/8
1/2
1 3/4
1/2
2 1/4
22"
~~16"~~
1/4
Bolts spaced 3" ap

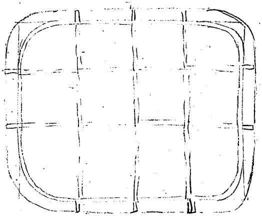
Nov 26th '89

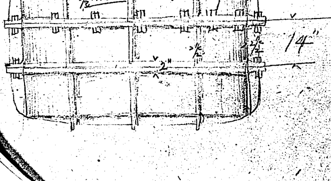
Made Nov 26th '89 in Blacksmith shop



Monday Eve. Dec 2, 89.

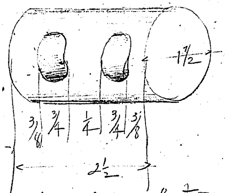
Monday Evg. Dec 2 '89




3/8" metal
Ribs 1/2" thick by 2 1/2 deep.
1/2
2"
2 1/4
14"

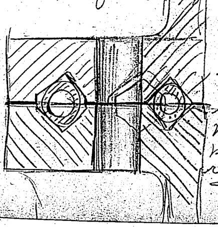
Monday Evg. Dec 2 89

3) 7.
41.


1 1/2
3/8
3/4
1/4
3/4
3/8
2 1/2

6 of this. 2 to each transformer.
of 1/2 Copper Rod.

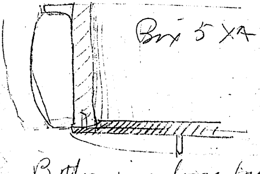
Detail of Flange Joint



The bolt holes and (r) slots are cast in the pattern.

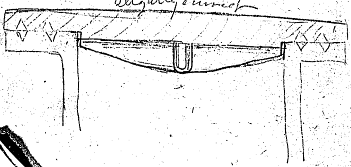
The side Ribs are loose pieces (and with the bottom) are pinned in their respective positions

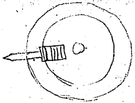
Monday Evg. Dec 28

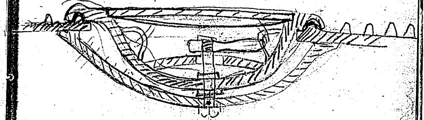


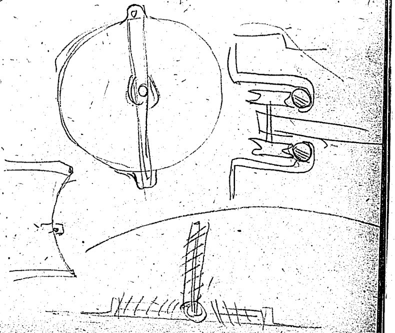
Box 5 X 4 X 3½

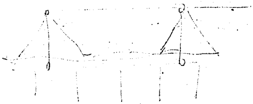
Bottom is a loose piece and merely pinned for the bottom casting.

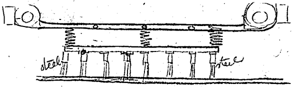

slightly curved

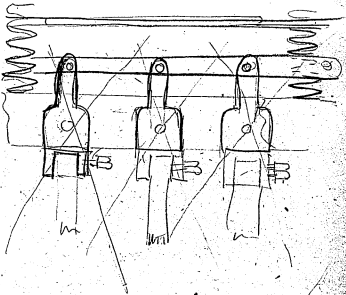


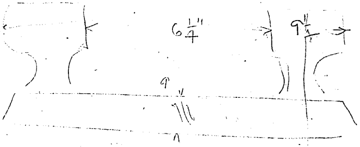


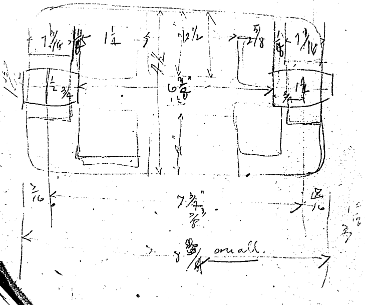





steel
steel







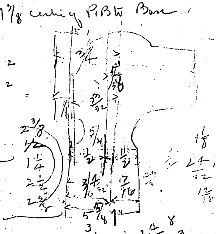
1 5/16
1 1/4
1 1/2
2/8
1 1/8
1 5/16
1/2
3/4
6 3/8"
1 1/2
1 1/4
3/16
7 3/8"
3/8
5/16
8 3/8 overall.

Dec 7. 81

2" - Diameter of Armature

3/8 from Arm to Pole Plate.

1 7/8 centre of P.B. to Base.



3/4
5/8
3/32
5/8
1/2
1/2
3/4
5/16
5 5/8
1"

(1 9/16) 2
(1/4) 2
1/4
2 1/2
2 3/8

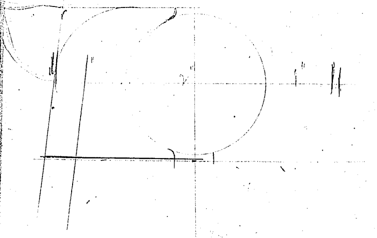
17/18

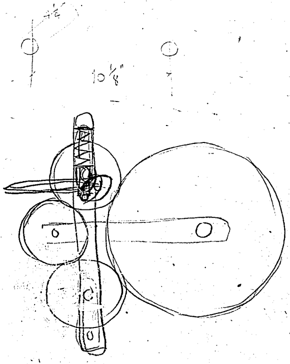
2 3/8
1/2
1 1/4
2 1/2
2 3/8

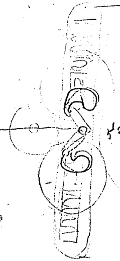
1 1/2
9 1/4
8 3/4

8 3/4

1 1/4
2 1/8


2"
1"


1/2
10 1/8"



550

43R

550
75
2750
3850
53) 41250 (800,
414
00

~~700 per wheel~~

30

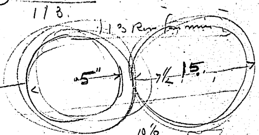
~~49~~

p = 78) 528000 (67%.
468
600
546
5400

770

$1\frac{3}{4}$
37
3
1.6 p 2

60) 6770 Rev per ft.
113.



12

t = .025
.164
.025

13
.025
65
26
.325

.325

.325

$10\frac{1}{8}$
$7\frac{1}{2}$
$2\frac{5}{8}$

9

P = pressure between the two wheels
μ = coeff of Friction
T = Tangential resistance

$$P = \frac{T}{\mu}$$

---

v = velocity of Pitch surface ft per sec
HP Horse P

$$T = \frac{550H}{v} = \frac{550 \cdot 12}{\quad}$$

$$T = \frac{550H}{v}$$

163.

15.7"
6) 1206
2.0 per sec.

15.7
12) 3140 (26 ft per sec.
24
74
72

26.5 ft per sec.

550
163) 4400 (27
170
1680

550.12
26.5
2
530

100
550
6600

26.5) 6600.0 (250.
530
1300
1335

T = 250 lbs.

$\frac{21}{64}$ $\frac{22}{64}$ $\frac{11}{16}$ $\frac{11}{32}$

P = ~~550~~

$$P = \frac{250 \cdot 2}{\cancel{500}} = \frac{250 \cdot 2}{5.0.0}$$

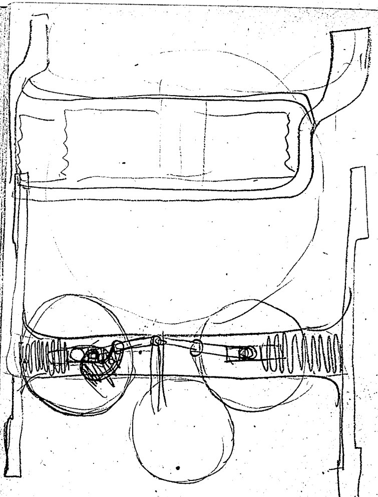
~~P = 550~~

6600
5.3

5.3) 6600 (1246.

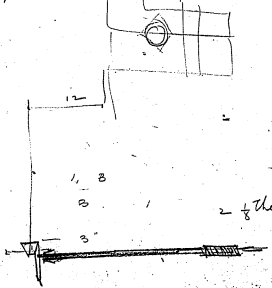
1246 lbs.
623 lbs per wheel

130
106
240
212
280



12 H.P.

12 H.P. 625 lbs per wheel
7½ H.P. 400 lbs per wheel.


12
1, 3
3
3"
2 ⅛ thread.

Dec 9.84 Spring for Sprague Motor ~~[illegible]~~ Friction clutch

W_1 Greatest safe load

δ_1 Corresponding deflection (n) coils 3/8 wire (d)

$$W_1 = \frac{0.196\, f\, d^3}{r}$$

1 3/4

$$\delta_1 = \frac{12.566\, n f r^2}{G d}$$

$G = 11,000,000$. 1/4" movement δ

250 lbs.

r = rad.

1 3/4

7/8

f Greatest safe shearing stress

f = 20000. lbs.

$$W_1 = \frac{0.196 \cdot \overset{\overset{160}{800}}{\cancel{20000}} \cdot .052}{\cancel{.875}}$$

.196
160
11760
196
31,360
.05

3/8 = .375

.125 . .140625

.052 734375

9/64

$$\frac{.0196 \cdot \overset{160}{\cancel{20000}} \cdot .052}{.875}$$

.875
.175
.007

4

3/8 12/8 1 1/4

36
2
72

.196
160
11760
196
31,360
.052
6272
15680
.007) 1.63072 (233,00
14
23
21
20

233.

$$\frac{0.196 \cdot 20000 \cdot (.375)^3}{12.566 \cdot 5 \cdot \cancel{20000} \cdot \overset{1.53}{\cancel{3.06}}}$$

1.75
3.0625
3.06

~~11000000~~ . .375
~~502~~
~~172~~
55

12.566
1.53
37698
62830
12566
19.22598

.375
55
1875
1875
10,625

~~absurdus~~

absurdus.

.5 10.6) 19.22598 (1

$$\frac{0.196\, f\, d^3}{r}$$

5 Coils.

$$\frac{0.196 \cdot \cancel{20000} \cdot \overset{\cancel{10,000}\ 1250}{\cancel{.125}}}{7/8}$$

.196
.1250
196
7500
11250
1250
245000
2
490.

245 lbs

12.566 . 5 . ~~20000~~ . 4²

~~11000000~~ . .5
~~550~~
~~110~~
55
.5
275

25132

.275) 25,132 (

$$\frac{0.196\, f\, d^3}{r}$$

$2)\overline{.375}$
$.1875$

$$\frac{0.196 \cdot 20000 \cdot .1875}{1375}$$

$$\frac{.0196 \cdot 20000 \cdot .0830}{\cancel{1}}$$

1660.00
.196
9960
14940
1660
325.360

325. lbs.

$$\frac{12.566\, n f r^2}{G d}$$

$$\frac{12.566 \cdot 2\cancel{0000} \cdot \cancel{4} \cdot 1}{\cancel{1000000} \cdot .4375}$$

27.5

.4375
275
21875
30625
8750
1203125

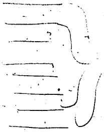
12.03125 | 12.566 | 1.

Test spring wire Dec 9 1889

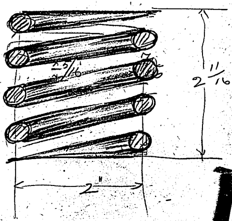
4 coils. 7/16 wire - coils separated 5/16 inch. 2" dia ~~outside~~.

29/16
15
43/16 = 2 11/16 long.
32 11/11

325 lbs with a deflection of one inch

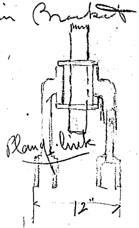


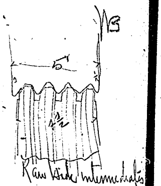
28/16 15/16 43/16 = 2 11/16 length of spring



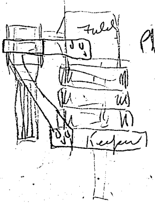
Dec 10 89

Slides commence 6½" outside Center of main Bracket

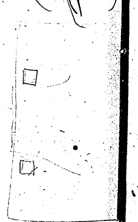

Flange link
12"



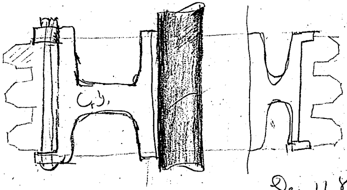
Raw Hide Intermediates


Fulcl
Keeper

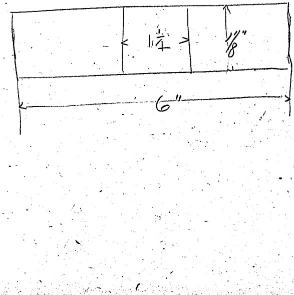
Plan of Bracket (clay fashion)



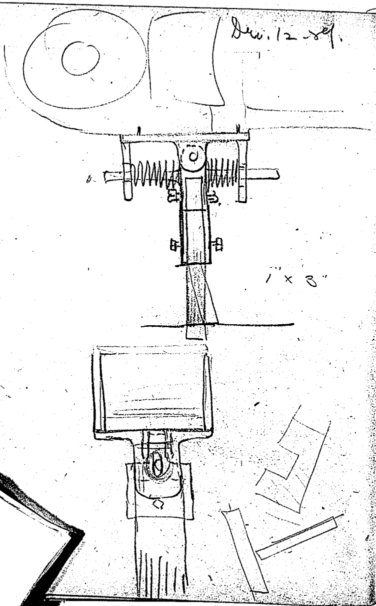
Sketch Construction RawHide Gears.

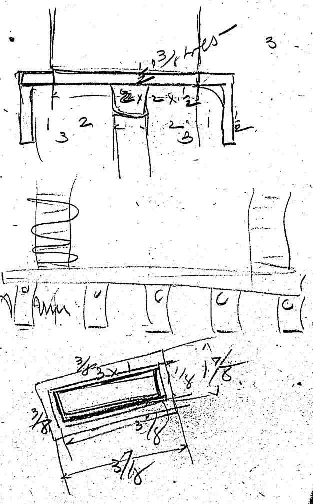


Dec 11 89



Dec. 12-89.




3/8 holes
3
1/2
2 x 2 x 1/2
1
3
2
2
3
1
1/2
3/8
3 x 1
1/8
1 7/8
3/8
3 7/8
3 7/8

Dec 12-89 Brush holder springs for track cleaner

$W_1 = \frac{0{\cdot}196\,f\,d^3}{r}$

$d_1 = \frac{12566\,n\,f\,r^2}{G\,d}$

$\frac{25 \times 25}{}$ .015625

1"

20 0000

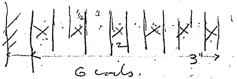
~~40000~~

20 1 7 0 0

$\frac{196 \cdot \overset{400000}{~~20000~~} \cdot 015}{~~5~~}$

196
40000
7840 ~~000~~
.015
39200
7840
117,600

3"



6 coils.

$2\frac{3}{4}$

$\frac{12566 \cdot 6^3 \cdot ~~20000~~ \cdot ~~25~~}{~~11000000~~ \cdot ~~25~~}$

~~550~~
275
75
~~800~~

20000

.5275)37,698 (

$\frac{196 \cdot ~~20000~~ \cdot ~~015~~}{~~75~~\ ~~103~~}$

.196
4000,0
784 — ¼ inc.

25
103
.75

$\frac{0{\cdot}196\,f\,d^3}{r}$

d = .0625

.000244140625

.000238328

.00024

.002

.000216

.75
.75
375

$\frac{196 \cdot \overset{40000}{~~20000~~} \cdot .00024}{~~5~~}$

.7840
.01624
31360
15680
187160

1.8 lbs.

187~~5~~

.0065392.03

.006

225
75
1125
~~450~~
~~5~~0625

7840
.006
47,040

3/16 inc.

$\frac{12566 \cdot 6 \cdot ~~20000~~ \cdot 5625}{~~11000000~~ \cdot 557}$

110)37,698 $\frac{1}{3}$

12566 . ~~7~~ . ~~20000~~ . ~~25~~

3
12566.6. ~~5625~~ ~~225~~00

~~550~~ . 25
~~200~~ 111
2 ~~3~~ 25,000

$\frac{}{~~11000000~~\ ~~1875~~}$
550 ~~0875~~
~~1~~ 1575

550
.75
2750
3850
250

~~[illegible]~~ 12566

41.25)87,962 (2

175
125
3/16
.0625
1.00
1½
.0625
.0625
68750
7'

25
75
75
175
1875

$\frac{196 \cdot \overset{800}{~~20000~~} \cdot ~~006~~}{}$ ~~2~~2

~~75~~
~~03~~
.12
.06

1600
196
960
1440
160
31,360

. 31.30.

.03
.02
.006
3

25
103
.70

5625

$\frac{12566 \cdot 6 \cdot ~~5625~~}{550 \cdot ~~1875~~}$

12566
1.8
100528
12566
22.0188

$\frac{12566 \cdot 6 \cdot ~~25~~}{~~550~~ \cdot ~~4875~~}$

~~2200~~
1.0062

2200
~~4~~ 550

$\frac{1}{2}$

$\frac{0.196\,f\,d^3}{R} - \frac{12.566\,n\,f\,R^2}{G\,d}$ $\frac{f}{G} = \frac{1}{550}$

$\frac{.0228\,n\,R^2}{d}$

550) 12.56 (.022847
1100
1566
1100
4660
4400
2600
2200
4000

.022847
550
11450
1145
12.5950

Spring. $\frac{1}{4}$ wire.
7 coils.
$1\frac{1}{4}$ dia.

.1875

1.25
.625

.390625
1 $\frac{1}{2}$ .75

Ref. .0228 . 8. ~~.34~~56
.2579 / 25) .062 (.03

.273
.0228
2184
546
546
.0062244

.392
.0228
3136
784
784
.0089376

.25) .089 (.35
.25) .089 (.4

.448
.0228
3584
896
896
.0102144

$\frac{7}{4}$ $1\frac{3}{4}$
$1\frac{1}{2}$
$3\frac{1}{4}$

.19) .102 ($\frac{1}{2}$

.125 wire

.0228 n. 1" dia. .125

$\frac{.0228 . ~~10~~ 20 . 25}{~~.125~~}$ .4560

.125

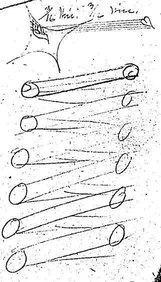
$2\frac{3}{16}$

$1\frac{3}{32}$

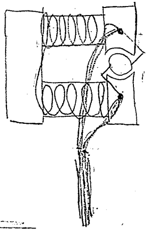
$\frac{.196 ~~4000~~ ~~20000~~ .002}{84 . ~~.15~~}$

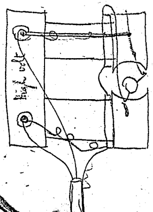
16,680 80,000

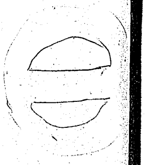
$\frac{.196\,f\,d^3}{R}$

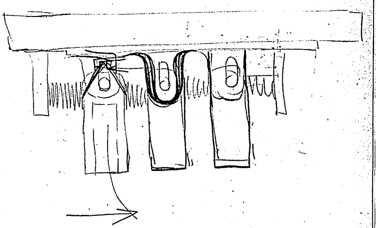


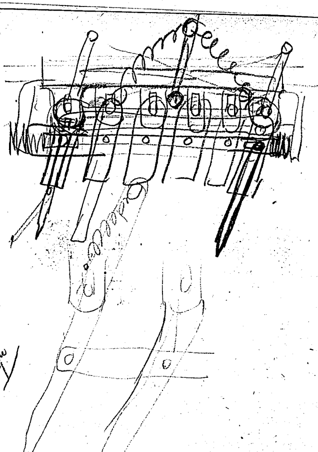
$\frac{3}{16}$ Wire.
E. Phosphorus Unknown.
Determinate Ext.
Ex Ex E—
for some —
long



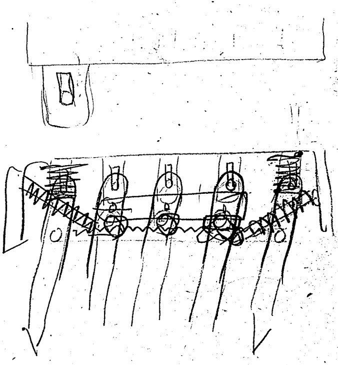

High volt





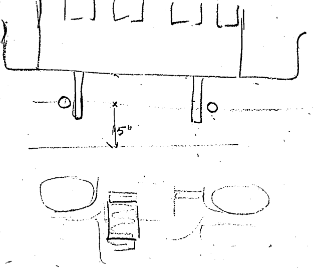


3/9 [illegible] 18.



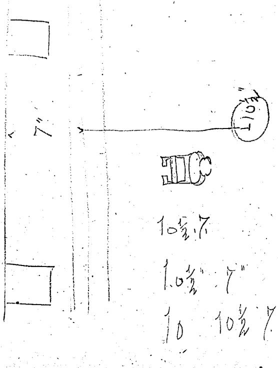
Dec. 17. 89.

2½" movement exhibition



10½" 7"

10½" 7"



10½ 7

10½" 7"

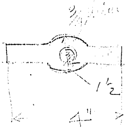
10 10½ 7

Air Brake Dec 19.

Brakes.
Rail Brush

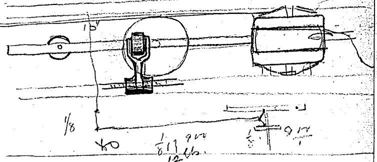
Gaspipe bearing,
Castings in end of Gaspipe

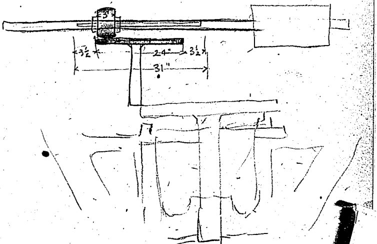
Threaded with 3/4 Pipe

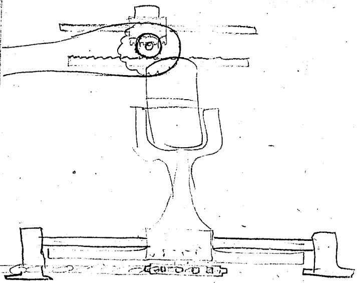

3/4 pipe
1 1/2
4"

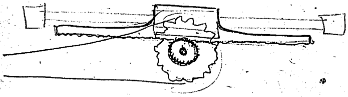
one of this

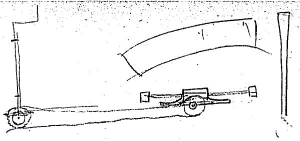
New Street Car Motor, Jan 8 1895

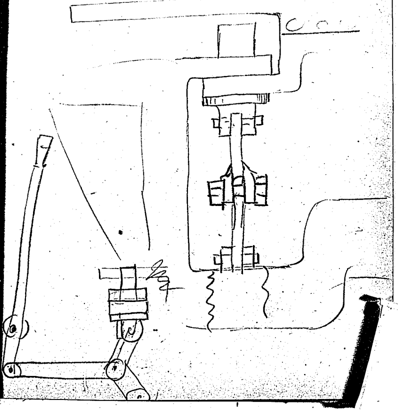

1/8
1/8
80
1/8 11 900
12 66
1/5
9 17

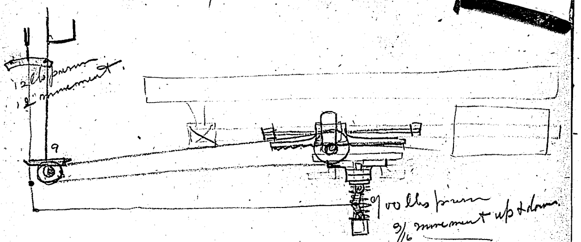

3½
3½
24"
3½
31"

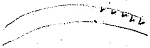


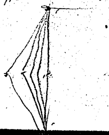




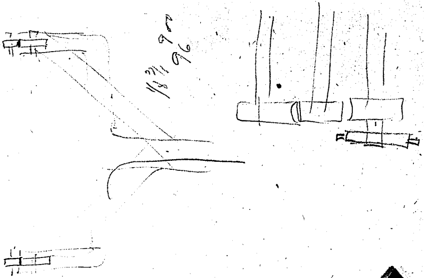



12 lbs pressure
12" movement.
9
900 lbs pressure
9/16 movement up & down.





12


1/8 3/4
96
900

12

.1274
7.00
89.1800

2) 89.18
44.

8, .127

7) 889
127

$\frac{60 \times 10^8 \times 110}{679 \times 3000} = \frac{357000}{90000}$

.447000 | 120000 .22

= 3.89

.127 ohms per ft
2350
6350
381
.44450

44 ohm resistance

100.

$\frac{100}{4.5} = 2\frac{1}{4}$ amperes.

Nov 8th 89

~~Motor Generator~~ Generator 1K.

100 Volts 1/4 Amps.
20 " 1 Amps

$Z = 30 \times 10^8 \times \frac{E}{N \times n} = 10^8 \times 30 \times \frac{110}{N \cdot n}$

Armature for ~~24~~ divisions ~~[illegible]~~

300 / 4 = 75

Winding for 100 Volts 1# 32 Bwg 28 times round
wire ~~790~~ feet "32 Bwg"

~~resistance = 43 Ohm~~

Drop in armature = $\frac{1}{4} \times \frac{43}{4}$ = 11 Volts

ohm

Revolutions = 3500 per minute

$Z = \frac{10^8 \times 30 \times 111}{60 \times 3500} = \frac{10000 \times 30 \times 111}{6 \times 35}$

= 160000 lines

160 000 : 20 000 lines/sq inch = 8 sq cm

~~3/4 x 1 3/4 = 1.9 x 4.5~~
4.05
8.55
.8
7.6 sq cm

3/4 x 1 7/8 = 20000.

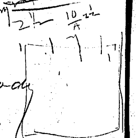
4.8 x 1.9
432
9.1 2
.9

8.2

3.5
1.22
3.0
6120

2 1/2 10/A

Diameter



Dia of armature body
2000) 16000
8000

1 1/4"

Bore 1 11/16"; Cast iron section

7/8 x 1 3/4 = 1.6 x 4.5 =
270
8000 7.20 =

leakage 20%; total flux of lines
160000 ~~80000~~
32000
192000 : 8000 = 24 sq cm : 2 = 12 sq cm

Dia. of core

160 000 : ~~18000~~ = =
32000
~~176000~~ : 18000 = 10 sq cm
192000 : 18000 = 10
10 : 6.45 = 1.55
355
330

dia. of core 1 7/16"

Magnet winding
Air space 1/4"

core. 2.75 x 1 7/8 = 4.03 sq in
= 30 sq cm

~~3.0 x 6~~ =

Resistance of air space

$R_a = 0.76 \frac{0.6}{30} = 0.014$

Resistance in wrot iron

6" = 15 cm length

$1{\cdot}62^{\text{sq in}} \times 6{\cdot}45 = 10{\cdot}4$

$$R_w = 0{\cdot}00085 \times \frac{15}{10{\cdot}4} =$$

Between shoulders 6¼"

length of bearing 1¼"

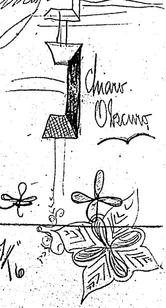
Area of armature outside

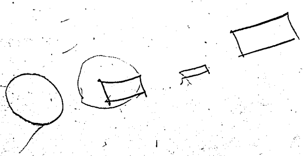
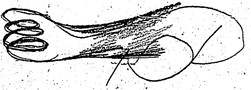
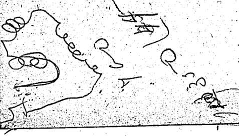
Wm Cunningham

746
15
3730
746
11190

$I_3 = \frac{R}{r}$

r = external circuit


Chiaro
Oscuro

Diameter of Core $1\frac{7}{16}$"